Development and Application of Hyperspectral Infrared Ozone Retrieval Products for Operational Meteorology

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STAR JPSS Annual Science Team Meeting
Ozone EDR Breakout 5e
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Outline

- SPoRT Paradigm/Overview
- Forecast Challenge & Ozone Retrievals
- Ozone Products
- Transition to National Centers
- New Product Development & Future Goals

SPoRT Mission and Paradigm

Test-Bed Environment

- ***Apply satellite measurement systems and unique Earth science research to improve the accuracy of short-term weather prediction at the regional and local scale***
- Bridge the "Valley of Death"
- Can't just "throw data over the fence"
  - Maintain interactive partnerships with help of specific advocates or "satellite champions"
  - Integrate into user decision support tools
  - Create forecaster training on product utility
  - Perform targeted product assessments with close collaborating partners
- Concept has been used to successfully transition a variety of satellite datasets to operational users for nearly 10 years

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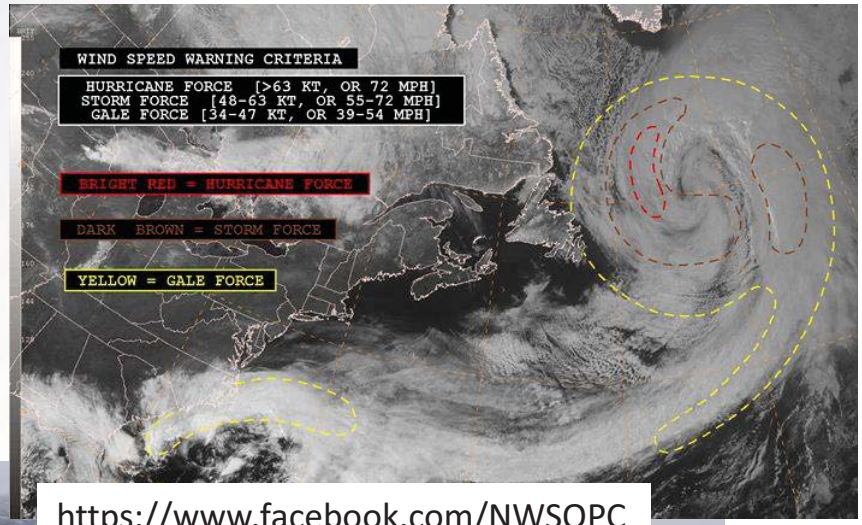
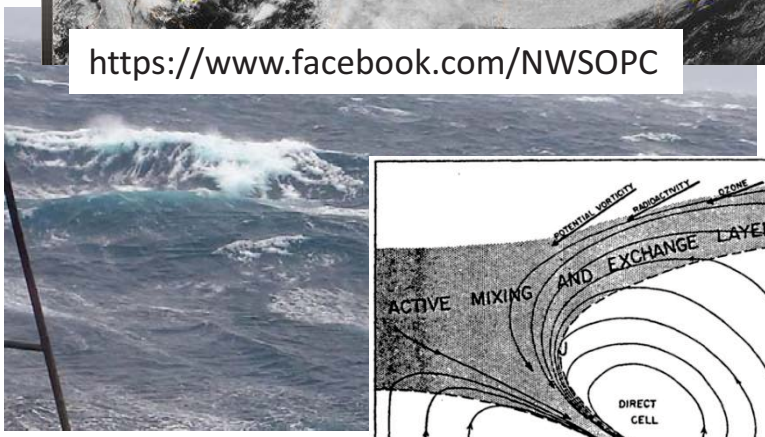
The Forecast Challenge and Ozone Retrievals

- The National Centers (WPC/OPC/SAB) are tasked with providing outlooks that involve forecasting the development of synoptic scale systems and associated severe weather
- OPC especially focuses on forecasting cyclogenesis and the development of hurricane-force winds in the North Pacific and Atlantic oceans
- Identifying regions of stratospheric air and the potential for tropopause folding can enhance forecaster situational awareness of impending cyclogenesis and high wind events
- Stratospheric air can be identified by potential vorticity and warm, dry, ozone rich air

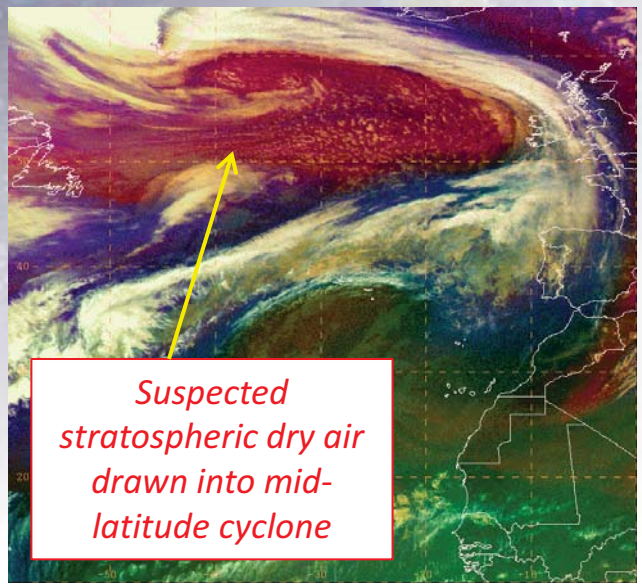


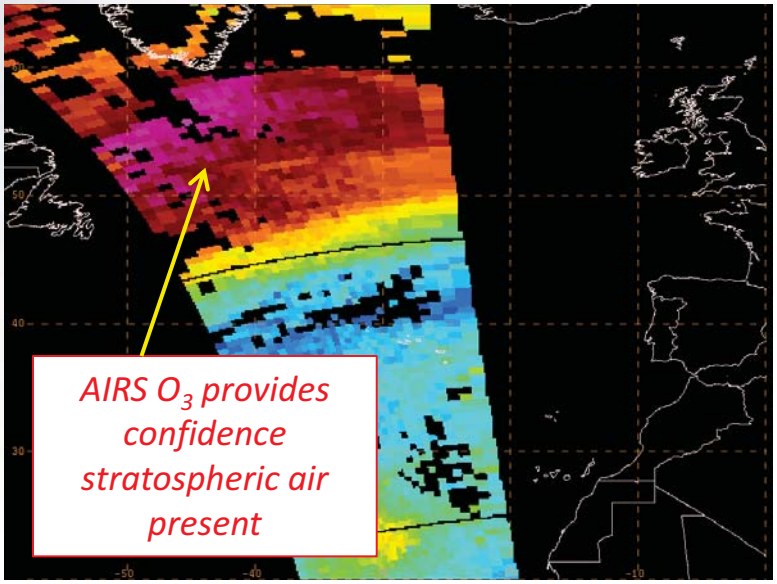
https://www.facebook.com/NWSOPC



(Danielson 1968)

The Forecast Challenge and Ozone Retrievals





- SPoRT has worked closely with the GOES-R and JPSS Proving Grounds to develop and transition ozone products in N-AWIPS format to OPC
- OPC has used the Air Mass RGB product to identify stratospheric air, however uncertainty exists about interpreting the new qualitative product
- Legacy AIRS ozone retrievals can be used to increase forecaster confidence in the Air Mass RGB and enhance interpretation

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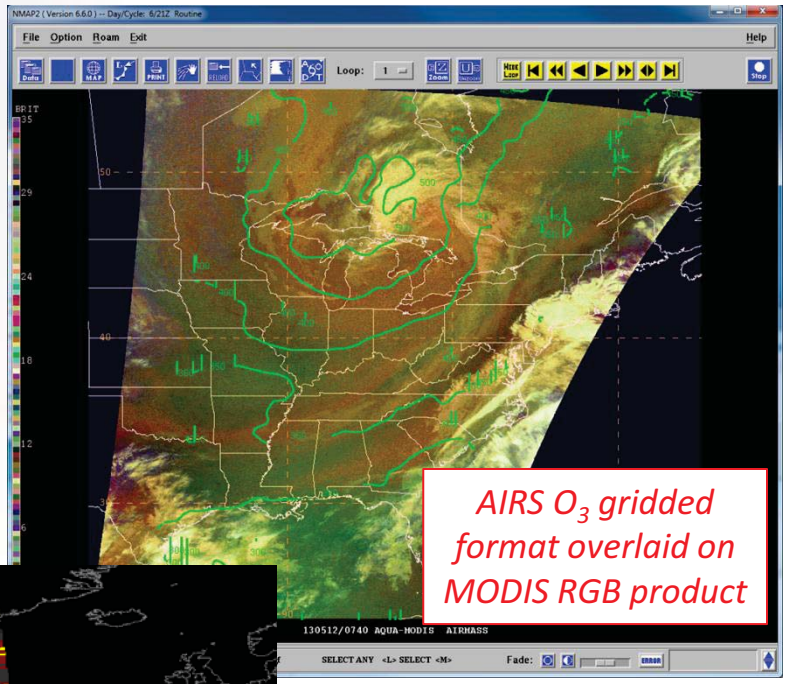
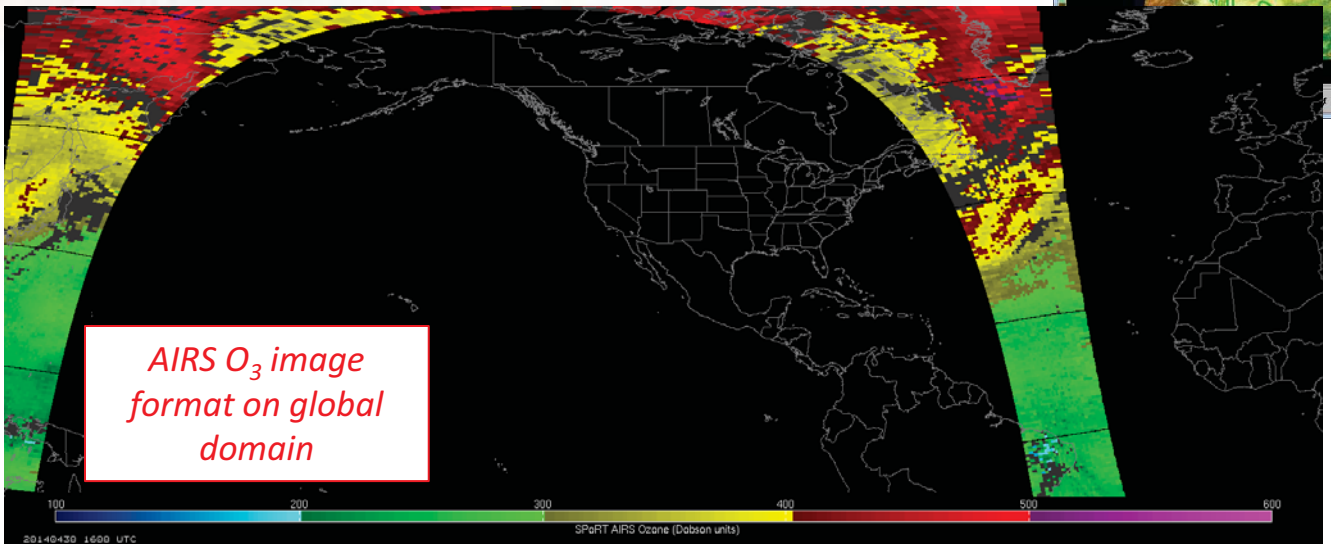
What products does SPoRT create?

- SPoRT produces 2 products in image and gridded format:
  - Total Column Ozone
  - Ozone Anomaly
- AIRS data obtained from NASA Land Atmosphere Near Real-time Capability for EOS (LANCE) with latency between 60 and 200 minutes



AIRS O_3 gridded format overlaid on MODIS RGB product

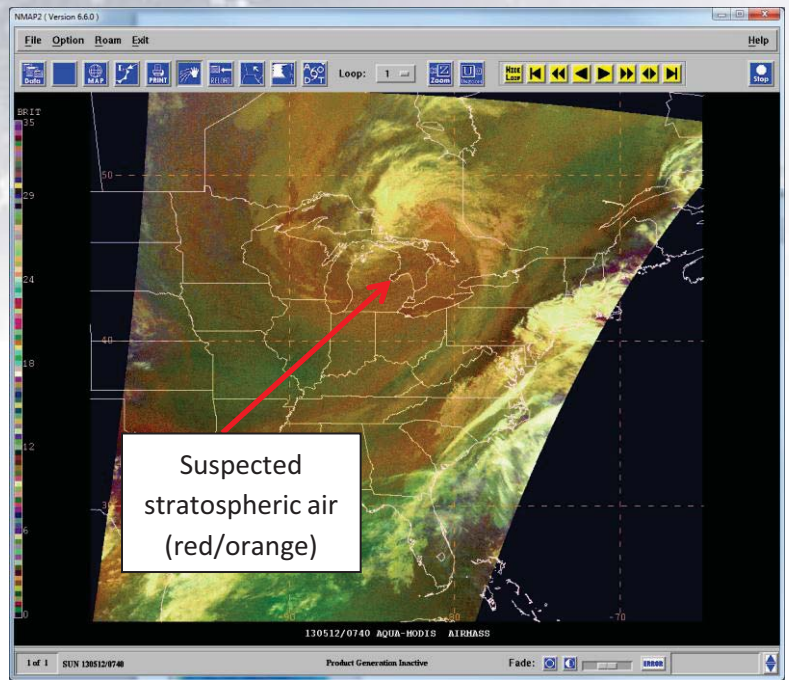


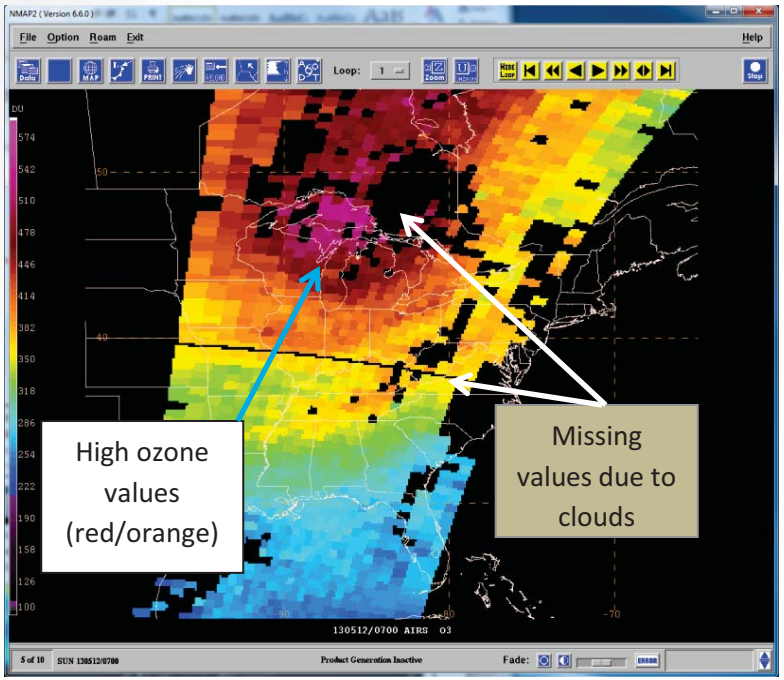
AIRS O_3 image format on global domain

- Product is provided in hourly swaths:
  - Products have a 4-hour latency to utilize all granules
  - Advantage is hemispheric coverage for OPC's domain

Example 12 May 2013

- SPoRT MODIS RGB Air Mass Image show a region of red/orange coloring surrounding the low pressure center
- AIRS Total Column Ozone confirms there are high zone values in the region

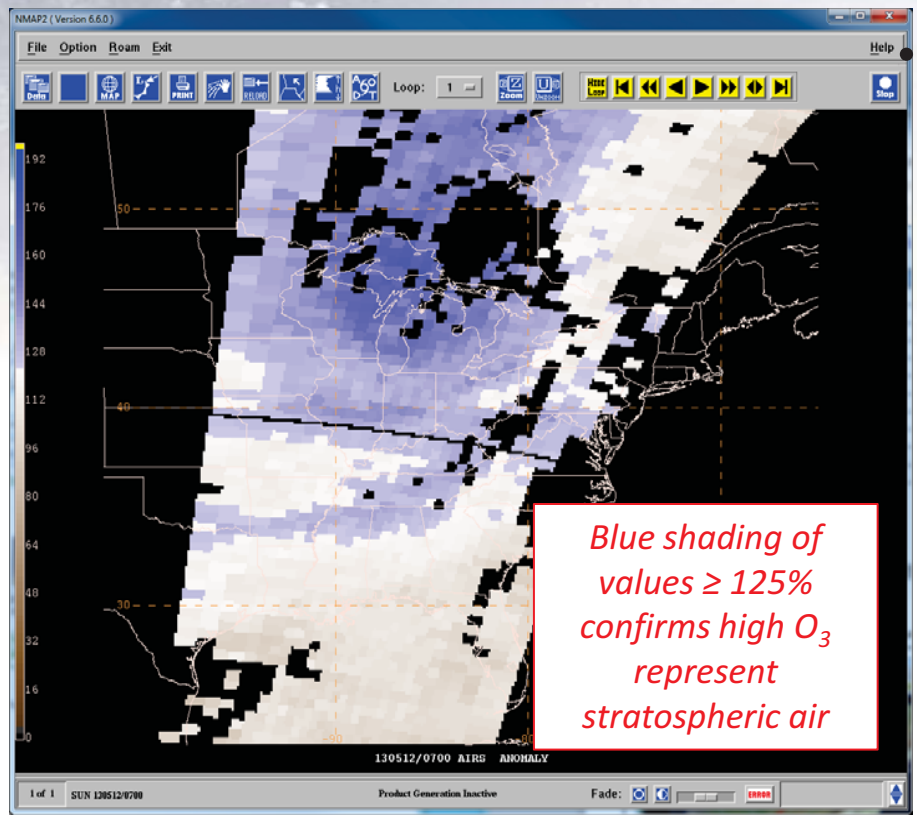




- How do we know if these high ozone values represent stratospheric air or are within the climatological range?

Ozone Anomaly Product

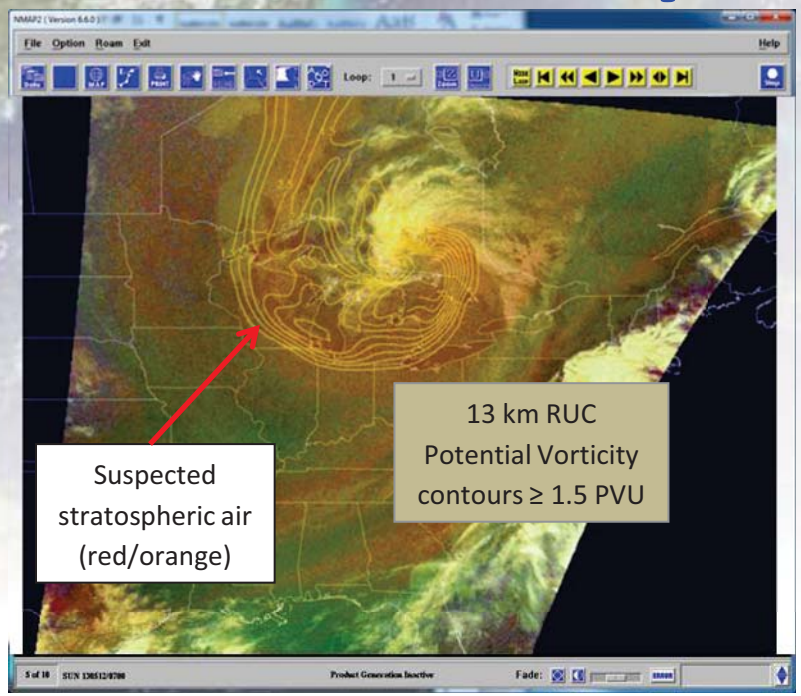
- Identification of stratospheric air based on high ozone values could lead to misinterpretation if the values actually range within climatology since the mean varies seasonally and spatially

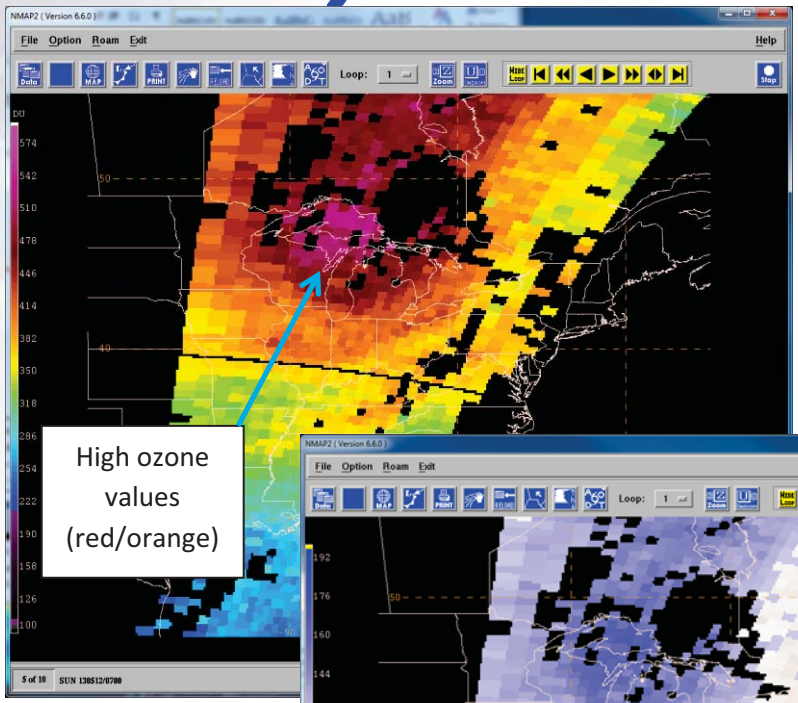


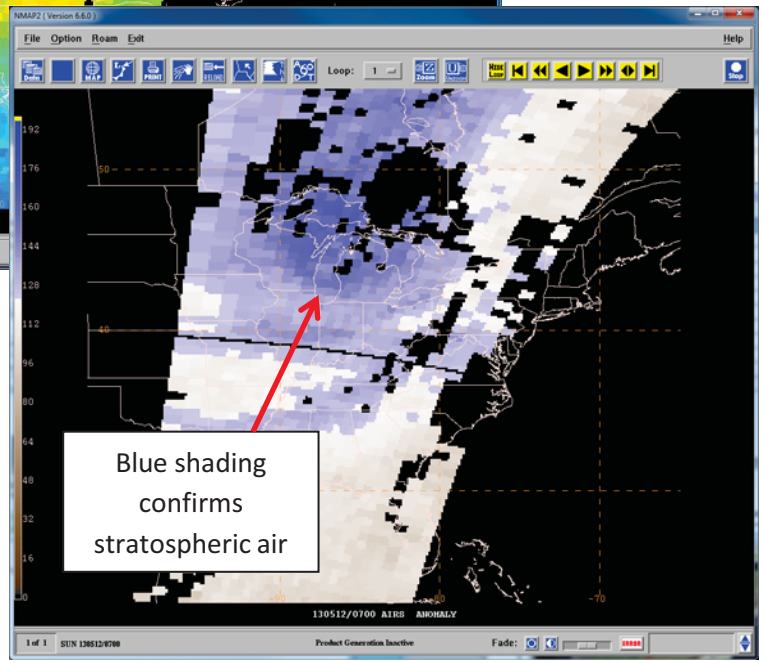
The AIRS Ozone Anomaly product clarifies the presence of stratospheric air based on:

- Stratospheric air has ozone values at least 25% larger than the climatological mean (Van Haver et al. 1996)
- Global and zonal monthly mean climatology of stratospheric ozone derived from the NASA Microwave Limb Sounder (Ziemke et al. 2011)

Example 12 May 2013







- SPoRT AIRS Ozone Anomaly product created as a percent of normal (0-200%)

$$PON = \frac{TCO}{climo}\ x\ 100$$

- Shades of blue represent stratospheric air (ozone values ≥ 125%)

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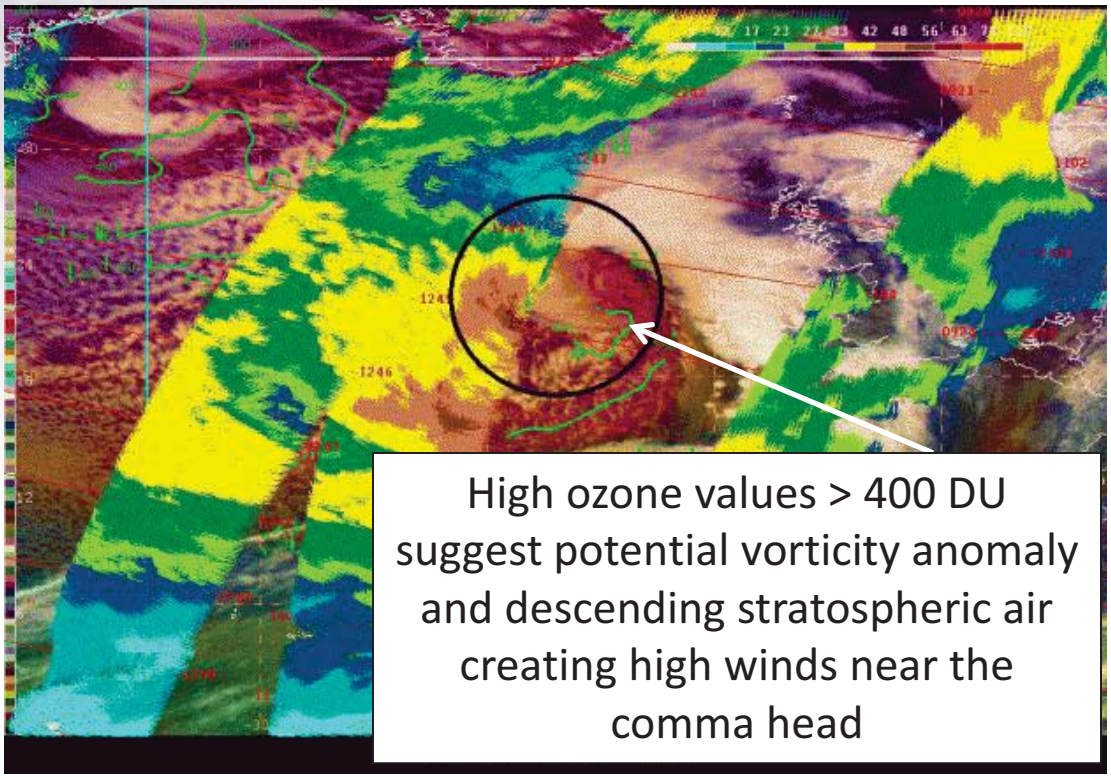
Transition to National Centers

- Ozone products evaluated at OPC, WPC, SAB winter 2014
- Forecaster Feedback
  - "Reinforce the evidence from RGB of the descent of stratospheric air with tropopause folding."
  - "This has allowed me to have confidence in assessing the RGB Airmass product and also in conjunction with gridded GFS output that a perceived PV anomaly is real or not."



SEVIRI RGB Air Mass image, AIRS Total Column Ozone (green contours), and ASCAT winds valid at 1400 UTC on 12/18/13. The black circle highlights the descending stratospheric intrusion near the comma-head/bent back front. Image courtesy of Michael Folmer Satellite Liaison at NOAA/NWS WPC/OPC/TAFB and NOAA/NESDIS SAB

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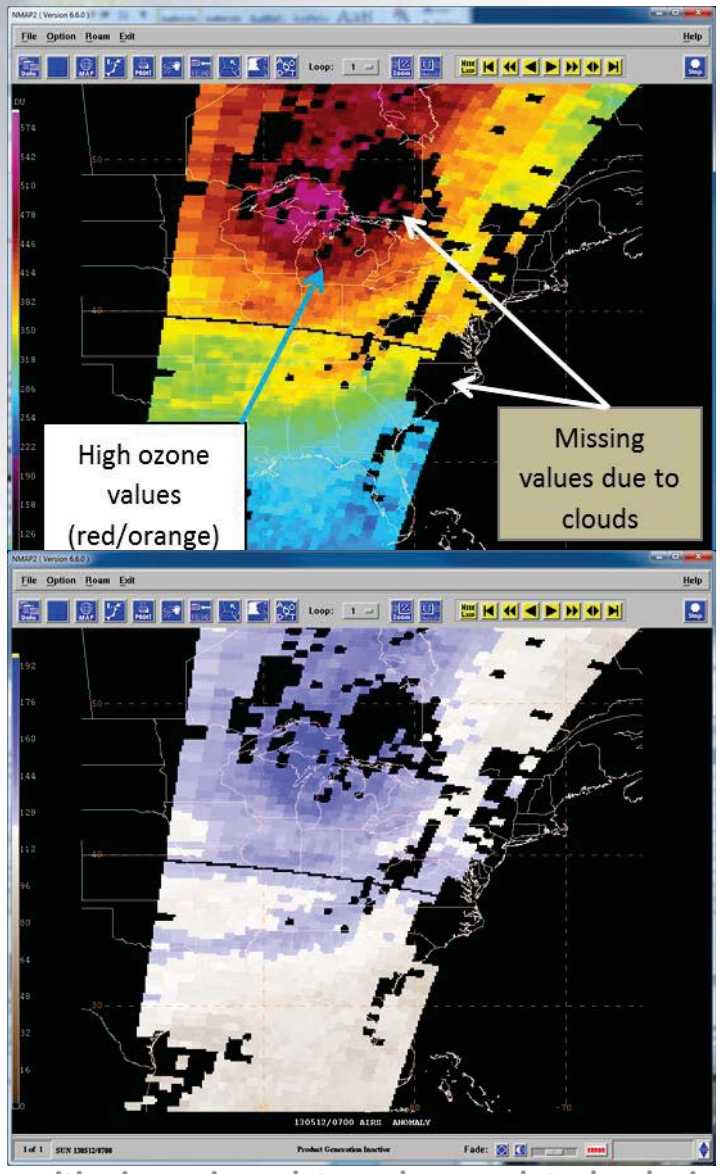
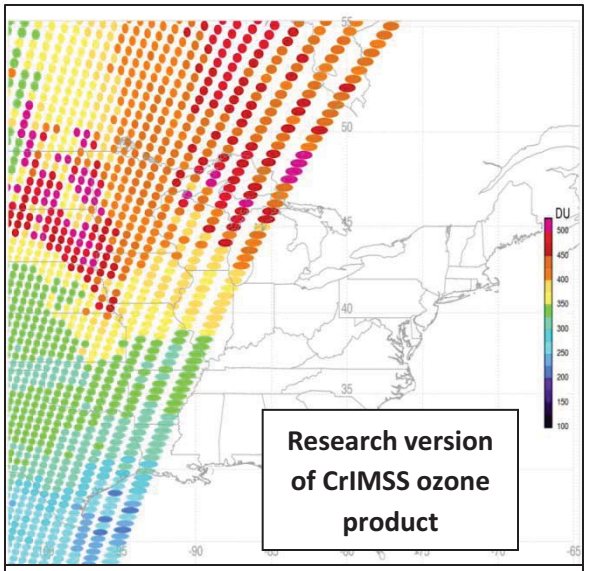
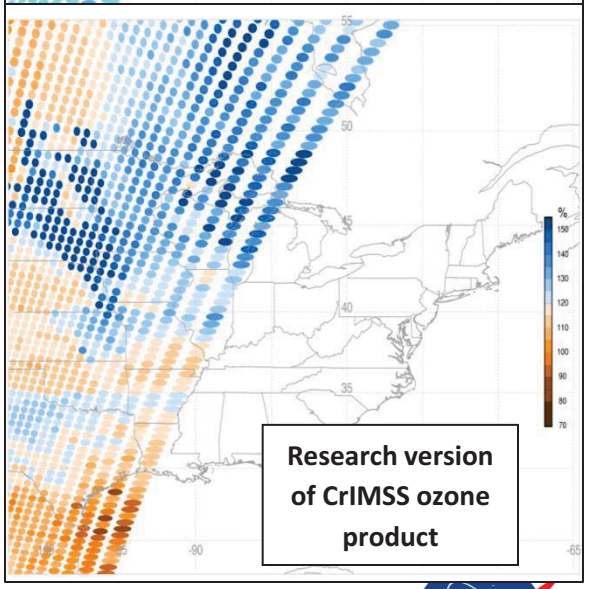
CrIMSS Ozone Products

- Expanding suite of ozone products to include CrIS
- Initial use of CrIMSS until NUCAPS CrIS is available
- Data obtained from SSEC PEATE server at an 8-hour latency to produce hourly swaths on a hemispheric domain
- NUCAPS CrIS ozone retrievals will hopefully be transitioned to OPC Fall 2014







Future Goals

- Currently training includes a quick guide
  - expand forecaster training to include a short module
- Make the products available in AWIPS-II
  - Currently funded joint SPoRT/CIRA/CIMSS GOES-R visiting scientist project to explore products in National Centers Perspective AWIPS-II

near the Great Lakes in the Air Mass RGB Imagery (top left) indicate stratospheric air and high potential vorticity near a jet streak. High potential vorticity values at 0800 UTC in the 500-300 mb layer correlate with the stratospheric air on the Air Mass RGB Imagery. The top right diagram shows high values of ozone over the Great Lakes region at 0700 UTC. The Ozone Anomaly product (bottom left) shows the high ozone values are a significant enough deviation from climatology to be considered stratospheric air. Non-convective high winds tend to occur under the region of stratospheric air. ASCAT measured winds ranging from 52-64 knots (27-33 m/s) over western Lake Erie and 33-52 knots (17-33 m/s) over Lake Huron (bottom right).

"There may have been 1 occasion where 1 pass did line up over the US with the spot I was interested in. In that case, it was helpful in reaffirming my suspicions on whether stratospheric air was present. Otherwise, the passes were few and far between and not particularly timely. If there was greater coverage of passes and not as much of a lag, it would certainly be useful."

- Adjust product according to forecaster feedback after the winter demonstration at OPC
- Expand the ozone products to other instruments
  - IASI
  - Suomi NPP instruments such as CrIS and OMPS
  - Explore a single product with AIRS, IASI, CrIS retrievals once NUCAPS is available

Questions & Comments

Email any additional feedback or comments

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